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ABSTRACT

A study compared the advantages and disadvantages of microform for classroom training applications. Three types of factors were considered: 1) student factors, such as material usage patterns, study styles, examination results, and fatigue; 2) instructor factors, such as attitudes and opinions, the role of the instructor, and the need for adjunct reference materials, and 3) administrative factors, such as logistics and the value which came from using microform. Three classes in an Air Force training school used microforms for a 30-hour course, and three control groups used the same material in hardcopy form. Findings showed that the trainees used the microform systems effectively and intensively over a one-week training period. The experimental group did as well as the control group on examinations. Almost three-fourths of the participants said they preferred to use the negative-image fiche for both classroom and home study. Fatugue resulting from microform use was not a pervasive problem. (Author/JK)

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MICROFORM USE IN A TECHNICAL TRAINING ENVIRONMENT – AN EXPERIMENT

By

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Denver Research Institute
University of Denver

TECHNICAL TRAINING DIVISION
Lowry Air Force Base, Colorado

May 1971

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AIR FORCE HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND
Lowry Air Force Base, Colorado

FOREWORD

The research project described in this report was conducted by the Denver Research Institute, University of Denver, under Contract No. F41609-70-C-0040. Mr. James P. Kottenstette was the Principal Investigator and Mr. Robert Grausnick was Research Associate. The contract as a whole extends from July 1, 1970 to July 1, 1971. The research reported here, however, was conducted from March 15, 1971 to April 30, 1971. The preparation of the course materials used in the research was under the direction of Dr. Anita S. West. This study represents a portion of the research program of Project 1121, Technical Training Development; Task 112101, Advanced Technology for Air Force Technical Training. Dr. Marty R. Rockway was the Project Scientist and Mr. Joseph Y. Yasutake was the Task Scientist.

The authors wish to acknowledge the cooperation and support of Dr. Edgar A. Smith, Contract Monitor, Air Force Human Resources Laboratory, Lowry Air Force Base, Colorado and Mr. William Neale, Training Advisor, 3750th Technical School, Sheppard Air Force Base. Acknowledgement also is made to Mr. Marvin D. Parks and Major Ed Larrabee, Department of Comptroller Training, Sheppard Air Force Base, for their assistance in providing the test bed used in the experimentation. Appreciation is extended to Sgt. Earl Atkins, Mr. Jerry Crawford and Sgt. Ed Wilson for their help in the revision of the training manual and to Mr. Jerry Crawford, Sgt. Robert Joseph and Sgt. Stan LeMaster, the participating instructors.

Other reports prepared under this contract include:

AFHRL-TR-71-44, "A Guide to Instructional Uses of Microform"

AFHRL-TR-71-42, "A Performance Evaluation: Microfiche versus Hardcopy"

This report has been reviewed and is approved.

GEORGE K. PATTERSON, Colonel, USAF
Commander

ABSTRACT

This phase of the research in technical training microform applications explores the comparative advantages and disadvantages of microform in classroom training applications. A 30-hour instructional sequence entitled, "Basic Computer Operation" was selected from an on-going course at the 3750th Technical Training School, Sheppard Air Force Base, Wichita Falls, Texas. A two-stage filming procedure was used to convert the training manual used in the instructional sequence to an innovative microform format in both positive and negative film polarities. Students in three experimental classes used the microform presentation, both in the classroom and in their residences, as the instructional medium for the course. The microform use patterns and course performance of these students were determined and compared with use patterns and the performance of students in three control classes in which identical instructional materials in hardcopy form were employed. The major result of this comparative analysis is that Air Force trainees can and did use the microform systems effectively and intensively over a one-week period. No significant performance decrements were encountered in the experimental classes. This study also examines a number of important considerations involved in utilizing microforms for training purposes, including the impact of microform use on instructional routine, administrative-logistics considerations, and student study habits. Although problem areas are identified in each of these categories, all can be resolved or minimized through equipment development and improvement. A personal reader is recommended for its positive values in classroom use, student residence use, and logistics. The significant accomplishments of this study were the demonstration of the feasibility of the microform

medium for classroom instruction and the development of an effective, innovative format which utilizes the unique presentation characteristics of microform to facilitate instructional communication.

SUMMARY

The Denver Research Institute, University of Denver. Microform Use in a Technical Training Environment--An Experiment. AFHRL-TR-71-43. Lowry AFB, Colorado: Technical Training Division, Air Force Human Resources Laboratory, May 1971.

Objectives

The objective of this study was to identify the comparative advantages and disadvantages of microform for classroom training applications in terms of (a) student oriented factors such as material usage patterns, study styles, examination results and fatigue, (b) instructor oriented factors such as attitudes and opinions, the role of the instructor, and the need for adjunct reference materials, and (c) administratively oriented factors such as logistics considerations and relative value added by microform utilization.

Approach

A 30-hour instructional sequence was selected from an on-going course at the 3750th Technical Training School, Sheppard AFB, Texas and converted to microform. Students in three experimental classes used the microform, both in class and in their residences, as the instructional medium for the course. The microform use patterns and course performance of these students were compared with use patterns and performance of students in three control classes in which identical materials in hardcopy form were employed.

Findings

1. The experimentation demonstrated that Air Force trainees can and did use the microform systems effectively and intensively over a one-week training period.

2. No significant performance decrements in terms of examination results were encountered in the experimental classes.

3. A history of administrative participation in the planning and execution of the experiment was developed and the logistics factors involved in implementing a program using microforms as the primary resource medium in technical training were descriptively analyzed.

Such things as maintenance requirements, equipment abuse or loss, storage facilities, power considerations, room planning, and repair strategies were considered.

4. Fatigue resulting from microform use was not found to be a pervasive problem in this experiment.

5. Almost 75% of the participating students expressed a preference for the negative-image fiche for both classroom and home study uses.

6. The innovative formatting and indexing techniques employed in this study were responded to favorably by the students and used effectively by them in the course of their study.

7. Students identified deficiencies in the reader-fiche systems used in this study and made recommendations for their improvement.

This summary was prepared by Dr. Edgar A. Smith, Technical Training Division, Air Force Human Resources Laboratory.

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I. INTRODUCTION

Background

Although microforms are now distributed widely in educational environments, the materials available in microform are of interest to a limited audience and are used more for research than instructional purposes*. Recent microform research has indicated, however, that students using microform presentations of educational and training materials perform as well as those using hardcopy presentations of the same information. In one reading experiment, for example, Kottenstette (1969) determined that there are no fundamental physical or psychological barriers to the use of microforms in communicating narrative information that students customarily encounter in hardcopy. Students are able to preserve skill levels (reading rate and comprehension) when utilizing viewer presentations of both descriptive and abstract narrative materials which reflect various levels of difficulty.

Baldwin and Bailey (1971) also found that students can perform adequately using microfilmed narrative reading materials. These investigators developed twelve tests which represent the various visual skills involved in the utilization of Air Force technical training materials. They found that the only significant performance differences between hardcopy and microfiche materials were encountered in tests which involved character recognition and symbol interpretation as opposed to reading continuous prose. They concluded that materials presented via microfiche are feasible for technical training purposes.

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* The term microform, as employed in this report, is intended to include all microimagery, whether in roll or fiche form and all reduction ratios found in commercial practice.

The applicability of the Baldwin and Bailey results to a different user environment was established in a replication of their study by Grausnick and Kottenstette "A Performance Evaluation: Microfiche versus Hardcopy," AFHRL-TR-71-42. Again, no fundamental difficulties were encountered which would legislate against the utilization of microforms in educational or training programs.

The study described here was part of a larger research effort designed to develop and evaluate microforms for use as primary source materials in Air Force technical training programs. Data from three separate investigations have been analyzed in response to the following basic questions:

1. Can Air Force Trainees use microform presentations of educational and training materials to an extent consistent with their use of hardcopy materials?

2. What are the optimal microform formats to be used in presenting technical training materials?

3. What are the advantages and disadvantages of microform presentations in actual classroom use as they effect such factors as instructional effectiveness, training logistics, and classroom administration?

An additional part of this research program involved the preparation of a user-oriented guide to the utilization of microform technology in technical training, based on a review of the literature and the insights which result from the total research effort.

Purpose of the Study

The research reported here was designed to identify the comparative advantages and disadvantages of microform presentations in actual classroom use. An instructional sequence was selected from

an on-going course at the Sheppard Air Force Base Technical Training Center in Wichita Falls, Texas. Hardcopy material used in the course was converted to microform, which then was used as an instructional medium in the course. The classroom experiment was conducted to assess the impacts of microforms use on the following three sets of factors:

1. Student oriented factors: student attitudes and opinions; material usage patterns; study styles (e.g., note taking, home study); examination results; fatigue characteristics.

2. Instructor oriented factors: the role of the instructor; instructor attitudes and opinions; the need for adjunct reference materials.

3. Administrator oriented factors: supervisor opinions and attitudes; logistics considerations; relative value added by microform utilization.

Organization of This Report

Since the research project reported here was exploratory in nature, it was essential throughout the course of the project to keep careful records of all factors which could operate to influence the experimental results. This research report is organized and presented to reflect the complexity and variety of observed incidents. To some extent, the report is organized as many such reports are organized; research procedures (Section II) and experimental results (Section V) are described in considerable detail. Factors operating to make the experiment unique, however, particularly those involving the logistics of carrying out the research, are described in Sections III and IV. The logistical considerations literally provide a general framework for placing the results in their appropriately exploratory perspective.

The style in which the remainder of this report is presented also deserves emphasis. It, too, grows out of the exploratory character of the entire research project. In a word, the style can be characterized as descriptive. To have employed a propositional or statistical style would have suggested the occurrence of much greater rigor and control than could actually exist. The discussional form of developing theory and presenting research results lends a feeling of the "developing" state-of-the-art in this dimension of educational technology. It is hoped, furthermore, that the discussional style makes the relevance of the research results to future applications of microform in educational settings easier to comprehend.

II. METHODS

Preliminary Work

Course Selection Procedures. The course of instruction was selected after an on-site visit to the 3750th Technical Training School at Sheppard Air Force Base. Three Training departments -- Communication and Missile Training, Aircraft Maintenance Training, and Comptroller Training -- were evaluated in terms of the following criteria:

1. Appropriate duration (at least twenty hours).
2. Continued student load prediction over the next year.
3. A minimum of "hands-on" training in the classroom.
4. Substantial outside reading requirements.
5. A mixture of non-commissioned officers and airmen in the trainee population.

Candidate instruction courses were identified in each department and representative study guides were obtained for later review and analysis. The course, "Data Processing Machine Operation", taught in the Department of Comptroller Training finally was selected for the classroom experiment. The course, which is divided into four instructional "blocks", is taught over a nine-week period. Hardcopy materials used in Block II of this course, "Basic Computer Operation," were converted to microfiche and presented to trainees via microfiche viewers. The training manual (SG/WB - 3ABR68530 - II) for this 30-hour block contained nine chapters and an appendix. Each chapter included review and/or workbook problems. The class was conducted for six hours daily over a five day period. Forty minutes of this time was devoted to breaks: four five-minute breaks and one 20 minute break each day. The final day was spent administering and reviewing the Block II examination.

Student Motivation. Student motivation to take a technical training course and to remain in it is generally quite high for at least three reasons. First, the assignments of trainees completing a course usually are much better than the assignments of individuals who are not technically trained. This is especially true for airmen trained in computer operation who, in all probability, will be assigned to a computer installation in preferred locations. Second, the course offers students an opportunity to receive training in a valuable career field while fulfilling their military obligation. This education often has valuable application outside the military when trainees leave the Air Force. Finally, there is the training situation itself. Students anticipate greater personal freedom in their field assignment which differs from the more structured military environment encountered in other situations.

These incentives differ from those operating in educational environments outside the military. Such strong motivation was considered essential in order to meet the additional demands of the microform system of presentation.

Study Guide Review and Revision. The original intent in reorganizing Air Training Command (ATC) materials for fiche presentation was for the content to remain virtually intact, modifying only the organization of information and the method of presentation to take full advantage of the microfiche medium. A few additional modifications of the hardcopy materials were required as part of the normal revision and update of materials for the course, independent of the research effort.

1. Errors were found in certain calculations, figures or textual materials.

2. Obsolete information and irrelevant materials were identified.

3. Materials occasionally were incomplete with respect to the objectives of the ATC Plan of Instruction.*

These and other considerations led to a decision to produce a revised hardcopy of the trainee text. That decision to supplement, enhance, and correct the textual materials, however, complicated the original research question. The requirement for a high quality presentation precluded consideration of the alternative for production of new fiche materials which would not reflect correction of recognized problems. The experimental design, therefore, was changed somewhat to consider achievement under three treatments: a control group using unrevised hardcopy, a second control group using revised hardcopy, and an experimental group using fiche materials.

As an example of the kind of reorganization of content (with only minor changes) that went into the revised hardcopy and microform editions, consider Study Guide #2, Numbering Systems. Study Guide #2 has as its objectives the explanation of the structure of numbering systems with bases 10, 2, 8, and 16 and the conversion of each system to any other system. The 1970 Study Guide organized this information into two sections: equal length explanations of decimal, binary, octal and hexadecimal numbers; and conversion rules and examples for each of the possible combinations. The 1971 (revised) Study Guide begins with an explanation of the binary system with examples of binary and equivalent decimal expressions. Conversion rules and examples between base ten and base two follow. The explanation of the octal system is related to the decimal and conversions for these two are

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* The entire "Data Processing Machine Operation" course was under a Service Test (Regulation 5218) at the time of the experimentation. The updating, revision and realignment of training objectives in the experimental block was anticipated during the Service Test.

given at this time. The balance of the material is similarly organized. The reason for this reorganization is to stress the reasoning behind numbering systems in order to reinforce the positional notation concept and to minimize the memorization of rules by building upon the principles as explained in the first example. The material presented is essentially the same as that which appeared in the unrevised edition. The microfiche edition of this study guide was able to give more motivational illustrations of the applications of the binary and associated number systems and included many more examples to assist in the acquisition of the skill. These would not have been appropriate to include in the text but were well suited to an optional reading presentation.

Another type of revision was required in Study Guide #6, Programming Languages. The unrevised edition had as its objectives trainee familiarity with two Assembler Languages, and two Compiler languages, COBOL and FORTRAN. Basic and Advanced assembly languages were first presented with the full range of advantages and disadvantages of each. COBOL was discussed contrasting it with machine and assembly language, and finally a discussion of FORTRAN was presented with the same kind of information. This was consistent with, but not sufficient, for achieving the objectives of the Plan of Instruction which included a recognition and knowledge of assembler and compiler language idiosyncracies. The revised edition now presents a full explanation of the Assembler Programming System. Subordinate to this heading are the sections on Basic and Advanced Assembler Languages with the differences between the two delineated. The second major heading then is Compiler Languages which summarize the basic similarities between compiler systems and contrasts compiler with assembly and machine languages. COBOL and FORTRAN are then

described separately and contrasted with each other to assist in identifying each of them. At the conclusion of the guide, in addition to recognizing the four different languages, the trainee should understand the differences between machine, assembly and compiler systems, and further should be able to distinguish between two assembly and two compiler languages.

Equipment and Materials

Viewers. The preliminary visit to the training facilities at Sheppard Air Force Base, led to a decision to use two sets of viewers in the experiment.

The course selected for the experiment is geared almost exclusively to use of the lecture method. Although very little material not included in the manual is presented in a lecture, slides and other visual aids occasionally are used for illustrative purposes. Trainees ordinarily do not read the manuals in class, instead they use printed materials to follow a lecture and to note highlights or make corrections. Extensive and sustained manual reading is done almost entirely outside of the classroom. To conduct the experiment, therefore, it was necessary to provide each trainee with both a classroom viewer and a home viewer. A tour of several residence halls at Sheppard revealed that they were quite suitable to accommodate the required viewing equipment. Typically there are three trainees to a room, although some rooms are equipped with a fourth bed which could be used when needed. The rooms contained three 30" × 20" desks situated near an electrical outlet; each desk was equipped with a suitable study lamp.

The reader selected for use in the residence environment was the Micro-Design, Model 100A viewer at 18X magnification (Figure 1). This viewer is well suited for home use because it combines sturdy

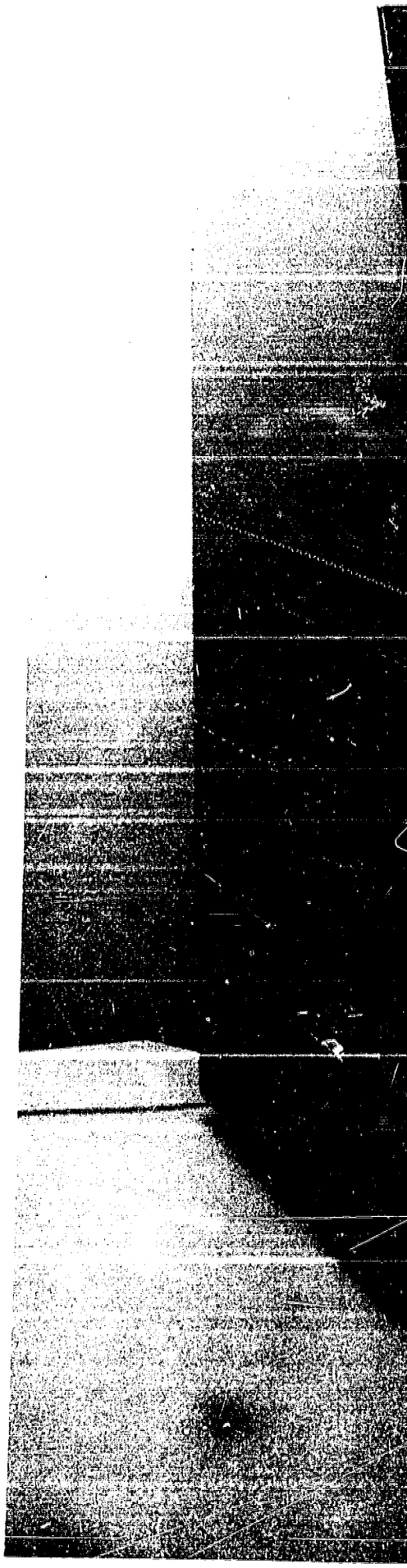

Figure 1. Micro-Des

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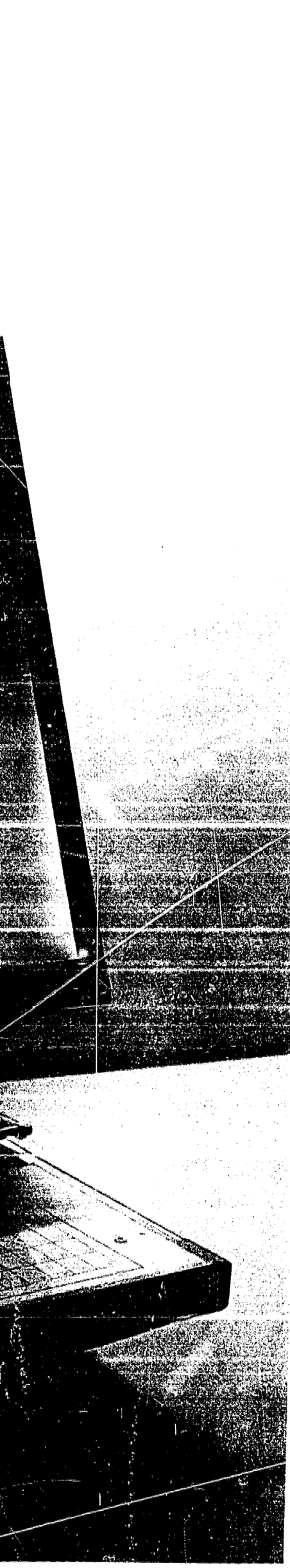

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construction (all steel and aluminum) with relatively small size (18-1/2" × 9-1/2" × 16"). Additional features which influenced its selection include a floating lens, constant focus, a non-glare high resolution screen, a rigid, smooth operating fiche carrier, and a long-lived, quartz halogen lamp having high-low intensity control. These features help insure easy operation and minimum maintenance requirements.

The Eastman Kodak Recordak Easamatic Reader, Model PFCD, which was used in the initial phase of this research program, was used in the classroom itself.* It is a table-top film reader designed specifically for viewing images on 4 by 6-inch microfiche having DOD, NMA or COSATI formats. The Easamatic viewer was selected on the basis of its inclined screen, double frame presentation, and frame locator characteristics (Figure 2).

Fiche and Index Cards. The fiche and the coordinated index cards used in the study were produced by the Denver Research Institute of the University of Denver (Figure 3). The reduction ratio used (20X) was specified by the contract due to its pervasiveness in government documentation systems.

The entire 185 page Block II training manual was filmed, requiring a total of thirteen fiche. Each fiche contained five rows and twelve columns for a potential capacity of 60 frames. Each fiche also contained an eye-legible heading which included the number of the fiche, the chapter of the training manual to which it referred, and a brief description of its content. The fiche were produced in both positive and negative polarities so that the student could decide which

* See Grausnick and Kottenstette, "A Performance Evaluation: Microfiche versus Hardcopy." AFHRL-TR-71-42.

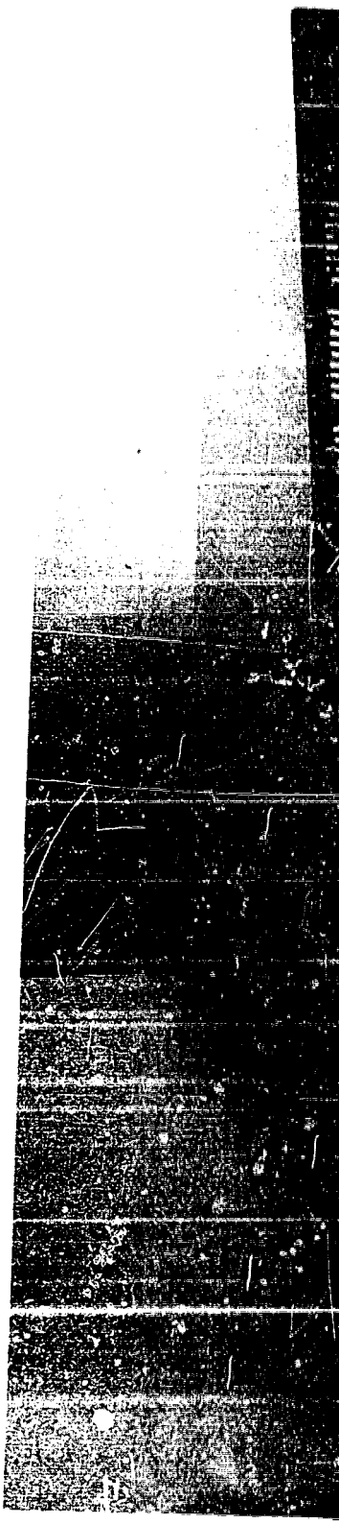
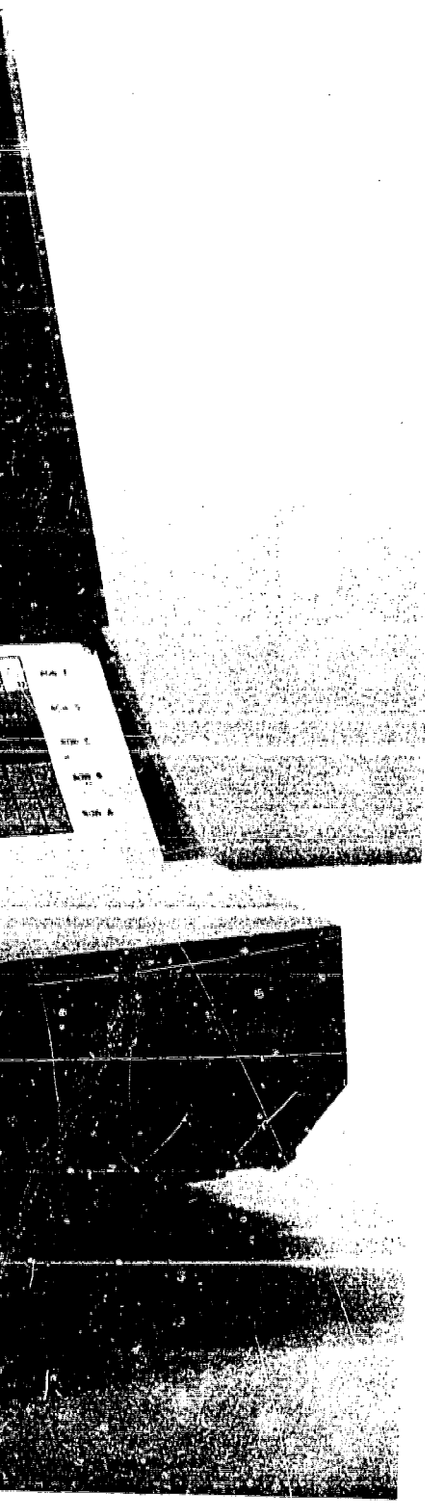


Figure 2.



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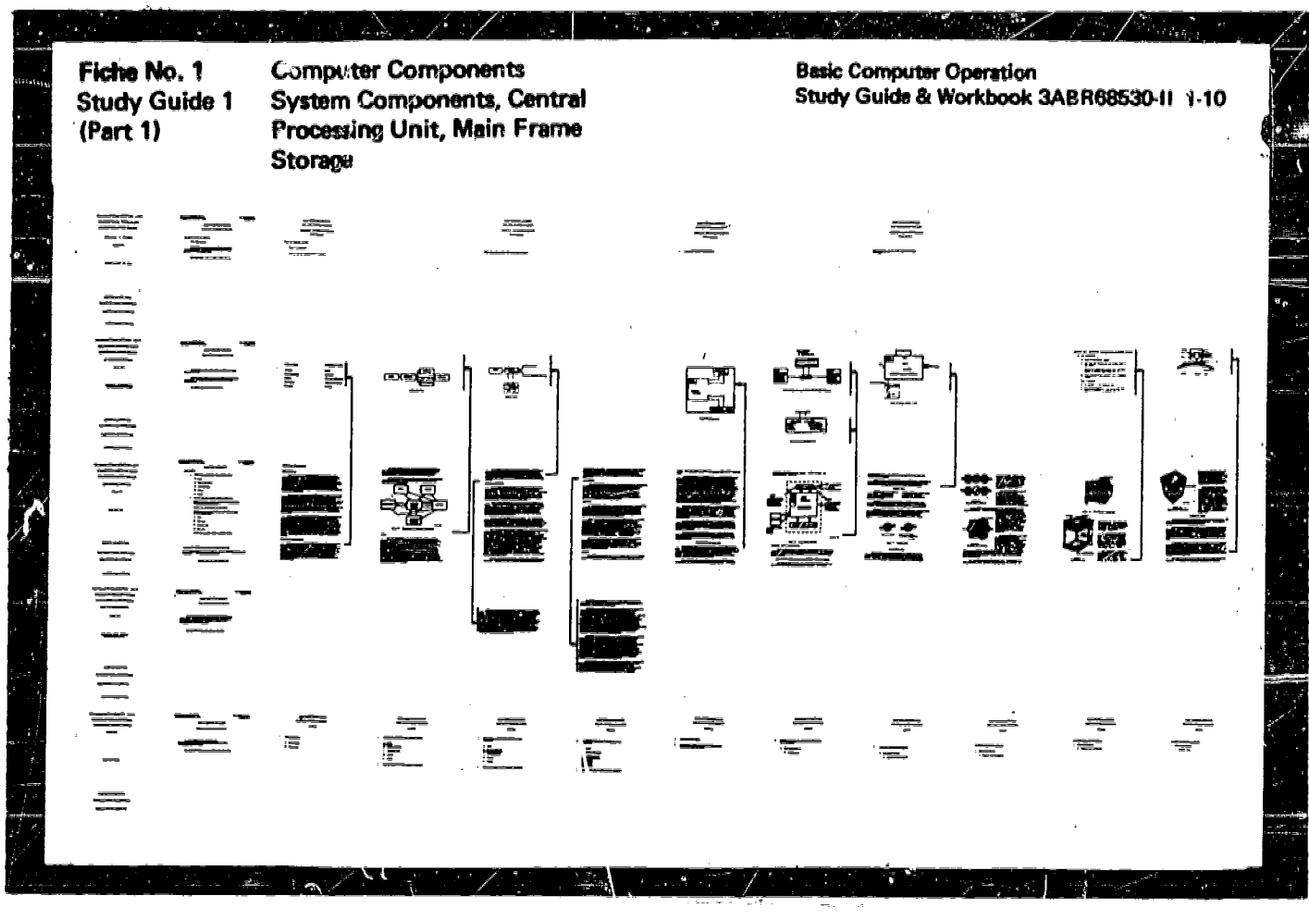

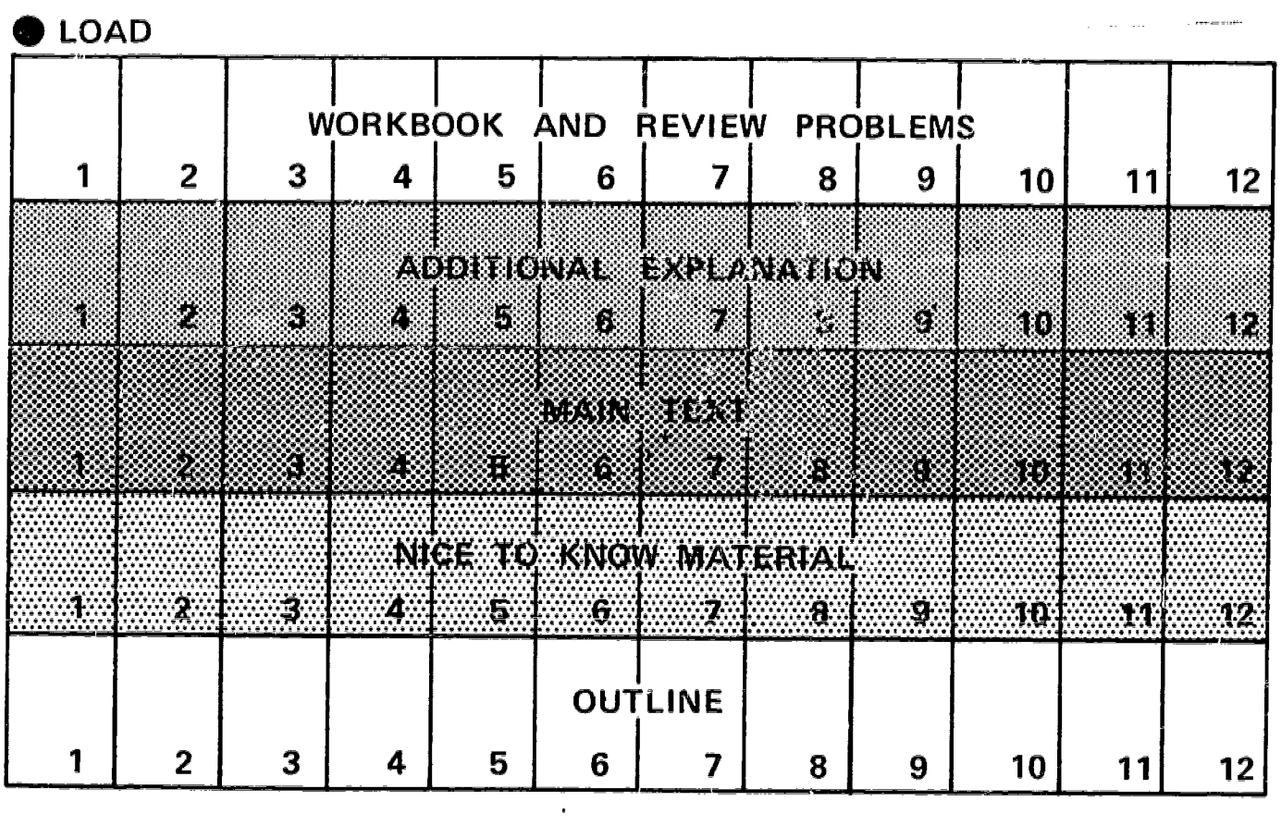

Figure 3. Actual-Size Photograph of a Fiche and Coordinated Index Card Produced by the Denver Research Institute, University of Den

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polarity to use in various situations. The fiche and the revised training manual contained identical information although the organization and formats were obviously different. The five rows of the fiche were developed according to the following format:

ROW A. Workbook and review problems were contained in this row. Specific questions or problems were located in the same column, but two frames (or rows) above the main textual material relevant to them. Therefore, if a student was unable to answer a question, or wished to verify his response, he had only to move down two frames to the material directly below the question frame to find the correct answer. In the training manual, workbook and review problems were located at the end of each chapter.

ROW B. This row, labeled "additional information," was reserved for extra explanatory material. It contained illustrations, diagrams, and short narratives which explained in more detail the textual material located one frame below. This additional information was located on the back of the page to which it referred in the revised training manual.

ROW C. This row contained the main text of the Block II training manual. This material was thought to be essential to an understanding of the topic area and contained the information on which the students were tested.

ROW D. This row was reserved for material directly complementary to the main textual material of the training manual. Students were not held responsible for information located in this row, but it was considered to be of general interest to students of computer operation. In the revised training manual, this material was also located on the back of the page to which it referred.

ROW E. A course outline was presented along this row. Each frame in this row was filled with the appropriate outline information. Material to which the outline referred was located directly above the frame in which it was listed. The training manual did not contain such an outline.

In the format described above, materials were presented horizontally in order to take advantage of the twelve frame capacity of the row as compared to the five frame vertical capacity. The concept of vertically relating supplementary materials to the main text was applied in this study to provide options for individual students, to discourage unnecessary repetition of explanation, and to promote self-diagnosis of areas of deficiency with the provision for self-help.

An index card located on each viewer was designed to coordinate with this format and provide students with an indication by row and column of their location within a fiche. When a new fiche is inserted into a viewer, the user may scan ROW E (course outline) to obtain an overview of what the fiche contains. He may then move the pointer knob to ROW C (main textual material) and begin to read. When a vertical line extending down on the left side of a frame is encountered, the user may move the pointer knob to ROW D ("nice to know" material). When a vertical line extending up on the right of a frame is encountered, the user may move the pointer knob to ROW B (additional information). If the user wished to review the fiche after he had completed reading it, he could scan ROW A and attempt to answer workbook and review questions presented there.

The use of the format just described necessitated a filming technique which differs from conventional commercial procedures. Ordinarily, a commercial "step and repeat" camera would be used to create a microfiche master of the instructional information: the

master would then be duplicated to obtain the necessary dissemination or use copies. Since this filming procedure restricts the original material to both a single 8-1/2 by 11-inch page (nominally) and to the serial filming sequence (i.e., page 1, page 2, page 3, until the first row on the fiche is filled), another technique was developed for the filming of these materials. A two-stage filming process using a commercial press camera was employed. The instructional material appropriate to one fiche, usually a chapter in the training manual, was filmed four pages at a time, using a five-times reduction factor. The negatives obtained in this step were then stripped together in the proper sequence so that the final layout of the complete information for each fiche was assembled. This layout was then filmed at four-times reduction to create a fiche master consistent with the COSATI standards for film dimensions and information area. Both positive and negative masters were created and dissemination copies were produced using a commercial diazo microfiche duplicator. The density limitations of the dissemination copies were within the COSATI specifications but the overall resolution was lower, as determined with the NBS resolution chart during the development of the filming procedure. First-stage reductions produced a resolution of approximately 60 line pairs. Descriptively, this loss of resolution could be seen in the breakup of lines having an original stroke width (in the hardcopy) of less than 0.002 inches -- a condition that was rare in the materials filmed.

The use of an intermediate stage in the filming technique allowed the various linking lines to be added to the fiche, a requirement for this experiment that cannot be met using the "step and repeat" process. This filming flexibility was also used to title each fiche so that the eye-legible information was always readable when the fiche was in the viewer.

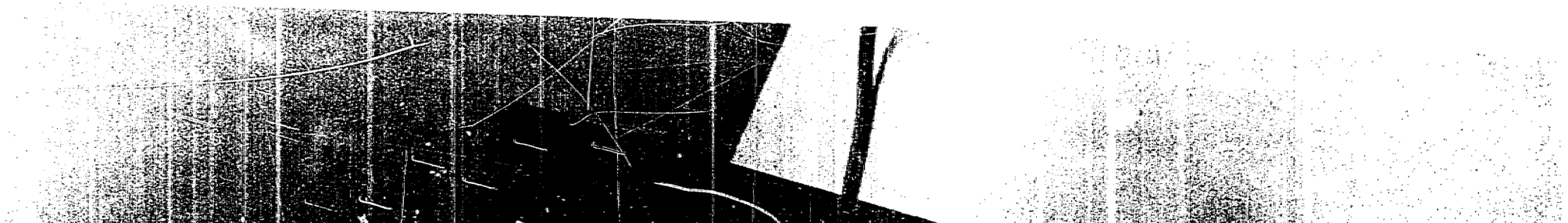
The Notebook. As noted previously, class time is devoted almost entirely to lectures which review readings in the training manual. To augment in-class work, each instructor and student was given a specially developed notebook. The notebook permitted students to follow a lecture on the screen presentation and to take notes in conjunction with it. A fiche-holder, designed to hold 13 fiche on each side, was included in each notebook (Figure 4). It was arranged so that the eye-legible heading of each fiche, which contained the fiche number and a brief description of its contents, was exposed to allow easy access to any desired fiche.

The notebooks also presented illustrations of each type of viewer and detailed operating instructions. Also included was an explanation of the formatting technique employed and instructions in how to use it. The final section contained an ample supply of note paper arranged by chapter. Students used these notebooks and fiche materials for the entire experimental period. At the end of the week, both fiche and supporting materials were returned in exchange for the revised Block II training manual (SG/WB 3ABR68530-II).

Research Strategy

One fundamental problem was explored in this study: "What are the advantages and disadvantages of a microform system as an instructional tool in actual classroom use?" A control group versus experimental group comparative approach was employed to deal with this problem. Three experimental classes, which used microform materials exclusively, and three control classes, which used the revised

Figure 4. Fiche - Holder -- Notebook.



training manual in hardcopy form, were involved in the study. One experimental and one control class was taken from each of three work shifts:

A Shift: 0600 - 1200 hours

B Shift: 1200 - 1800 hours

C Shift: 1800 - 2400 hours

Three primary instructors were involved in the experimentation. Each taught one experimental and one control class according to the schedule presented below.

Table I. Class Schedule

Shift	Instructor	Experimental Group	Control Group	Starting Date	Completion Date
A	1	X		March 17, 1971	March 23, 1971
A	1		X	March 24, 1971	March 30, 1971
C	2		X	March 24, 1971	March 30, 1971
C	2	X		March 31, 1971	April 6, 1971
B	3		X	March 31, 1971	April 6, 1971
B	3	X		April 7, 1971	April 13, 1971

Each participating instructor taught the Block II course to an experimental class and a control class, both of which were in the same workshift. No attempt was made to predetermine the size or composition of the classes after the first week. Recycled students -- those who failed a block examination and began the block a second time -- were included in the participating classes.

Demographic Characteristics

An examination of the demographic composition of the experimental and control groups revealed important similarities and only

minor differences. Thirty-eight students in the control groups took the final Block II examination compared with 34 students in the experimental groups. Two cross-trained students originally enrolled in experimental classes dropped the course and returned to their home bases.

All of the students in both types of classes were high school graduates. Exactly one-half of those in the control group had some college experience; eight percent (N = 3) had received college degrees. Similarly, 65 percent of those in experimental groups had attended college with eight percent (N = 3) graduating. Approximately 25 percent of each group had some previous experience with computers, primarily through programming or data processing courses in high school or college.

Fifty percent of the control group was age 20 or younger and 16 percent were 30 years of age or older, contributing to an average age of 23.1 years. The average age of students in the experimental group was 22.4 years; 43 percent were 20 or younger and nine percent were over 30. The experimental group contained more students between the ages of 21 and 30 although the mean age was younger because fewer people over 30 years of age were represented. The control group was composed of 58 percent airmen and 42 percent NCO's compared with 68 percent and 32 percent respectively for the experimental group.

The demographic similarities between the two groups facilitated the comparisons which were necessary to assess the effects of introducing the microform system into the classroom situation. Where differences of composition were apparent, such as the ratio of NCO's to airmen, the differences were considered in interpreting the results of the study.

Methods of Data Collection

Formal Examinations. Each class involved in the experiment was required to take an end of block examination after four days of Block II instruction. The examinations generally contained between 45 and 55 single-response, multiple choice questions valued at one point each; from six to eight conversion problems valued at five points each; and a written performance section involving the proper sequencing of the steps involved in performing specified operations. Standard end of block examinations which were not restructured in any way were used in the experimentation. Test score totals summed to 100 points.

Students advancing to Block III were required to meet defined criterion objectives during the first week of instruction in order to progress to the second week of instruction. Student performance grades at the end of Block III are based on satisfactory completion of USAF type "computer runs" performed in the job-oriented environment of the machine room atmosphere. Student progress is recorded by the instructor using a "criterion and performance" grading system which results in a final number grade.

Since Block III is a performance application of the theory learned in Block II and prepared for in Block I, the three block grades were used in the following way: Block I examination results were used to establish the equivalence of the control and experimental groups. Block II and III final results were used to demonstrate differences in performance when the medium of presentation was different. In addition, both control and experimental Block I, II and III grades were compared with a distribution of grades from previous classes to determine if the overall pattern of results had changed during the experimental period.

Students Microform Use Analysis. This variable was examined to obtain an estimate of the outside study requirements of the course and to compare student use of the instructional material by the two groups. The data which relate to this variable were obtained primarily from the "student-use check list" which was developed to obtain an estimate of the time spent studying outside the classroom. Experimental group members were asked to estimate for each day the total time spent studying (not including workbook and review problems), the percentage of study time spent in ROW B (additional explanation), the percentage of study time spent in ROW D ("nice to know" material) and the additional time spent on workbook and review problems. Control group members were asked to supply identical information except that for them the material which corresponded to ROWS B and D on the fiche was combined on the back of the pages in the training manual. Information regarding the use of material in the classroom was obtained through observation.

Student attitudes toward the use of microforms were assessed at two points during the experiment. A pre-class questionnaire, developed primarily to elicit demographic information, included questions designed to provide information regarding trainees' previous experience with microforms and possible negative attitudes or resistance toward their use. A post-class questionnaire was administered to determine whether these general attitudes had been affected by their experience with microforms. In addition, the post-class questionnaire elicited more specific student responses regarding the physical characteristics of the equipment and materials used, their effect on study habits and fatigue, comments concerning the environments for information use, and recommendations for the improvement of the systems. Classroom

observation and informal interviews with the students also contributed data related to these factors.

Instructor Microform Use Analysis. An historical approach to the attitudes and opinions of the instructors was developed through a series of semi-structured interviews with particular attention to the impact of microform use on teaching technique and on the role of the instructor. A close working relationship between instructors and researchers evolved during the experiment which allowed a daily critique of class progress and an assessment of the influence of the reader-fiche system as a mode of presentation.

Daily observations of each class were directed toward determining how instructors use different visual aids and other adjunct reference materials, how instructors used the microfiche readers to teach, how they used hardcopy materials, and how they used additional materials included on the fiche.

Logistical Analysis. A case history of administrative participation in the planning and execution of the experiment was developed with particular emphasis on the logistics of implementing a program using microforms as the primary resource medium in technical training. Such things as maintenance requirements, equipment abuse or loss, storage facilities, power considerations, room planning and layout, and repair strategies were considered.

III. LOGISTICS

Environment for Microform Use

The analysis of the logistics involved in implementing a microform system in technical training began with an examination of the environment in which the equipment was to be used. The classroom selected for use in this study was typical of those used in the Department of Comptroller Training. The room was approximately 15 by 27 feet and contained eight 30 by 54-inch tables arranged in rows down each side of the room with a center aisle. There were five sets of outlets along each wall, each outlet capable of accommodating two viewers. These outlets were newly installed for the experimentation and had the three-pronged (grounded) outlets compatible with the equipment used. Most other rooms in the building were not wired to accommodate equipment of the type used.

The size and characteristics of the room itself did not allow much flexibility in the arrangement of the desks or the readers. The permanent location of the projector screen/blackboard in the front-center of the room necessitated the center aisle, and there was insufficient space to slant the desks or alternate them for a better view of the instructor.

One drawback to the classroom selection was that the room contained the only entrance to an adjacent classroom which made interruption a frequent occurrence and tampering with equipment a potential problem. The classroom itself was reserved for the microform study during the experimental period. During normal operations, however, this would not be the case. If a wholesale conversion of materials within a training program were initiated, the readers would be in almost all classrooms and used 18 hours a day; the problem, then, would be one of establishing equipment maintenance and repair strategies. If, however, only selected blocks or segments of a program were converted to microform, the main problem would be one of scheduling for the maximum use of the equipment and the rooms within a particular department.

Married students enrolled in the technical school may live off base and must, of course, make their own provisions for study. These students usually comprise between 20 to 25% of a class. With microform use, this means improvising a study area with adequate space and lighting for extended study, within highly variable living situations. The on-base quarters provided for the resident students are quite suitable for accommodating the viewing equipment itself. Typically, there are three trainees to a room, although most rooms are equipped with a fourth bed which can be used during overload periods. Each student

has an individual desk (approximately 20 by 30 inches) which is located near an outlet and adequate desk lighting is provided.

A problem in the residence halls is noise. Trainees from different shifts and different squadrons are represented, sometimes in the same room, so that it is difficult to establish study hours or quiet hours which apply to everyone. In general, each squadron has at least an hour for study and an hour of quiet time (optional study) each day. *

Equipment Preparation

For this experiment, the viewers were transported from the University of Denver to Sheppard Air Force Base, Texas, by rented truck. After the 12 classroom viewers were in the room and uncrated (a process which took approximately 30 minutes) each viewer required about 15 minutes of cleanup and assembly.

1. The lamps had been removed for shipping and needed to be installed.

2. New reader index cards were installed.

3. The interior mirrors were cleaned and vacuumed to remove dust and dirt.

4. The viewer screens were washed and installed.

5. The glass-flat fiche holders were cleaned.

6. The focus and field settings were adjusted.

For each of the experimental tests, the above checkout procedure was completed while the participating students were completing their Block I examination in another room. After the Block I tests had been critiqued, the students who passed came to the experimental room

* The rules concerning the structure of a trainee's time are presently being relaxed so that the trainee is responsible for more of his non-class time.

and received their fiche materials and an orientation demonstration. This orientation session was an important factor in the successful utilization of the viewer-fiche system by the experimental students. The following points were emphasized in the orientation.

1. Students were told of the experimental effort and their involvement in it.

2. The contents of the notebook-fiche holder were explained in detail.

   a. Notebooks would be turned in after the Block II test and students would receive a hardcopy training manual in exchange.

   b. Students were given an explanation of what a fiche is and that they are sensitive and require a certain amount of care in handling. They were told that polarity preferences were theirs alone.

3. Students followed written instructions to insert the fiche and align it properly.

4. Students used the viewer-fiche presentation to follow an explanation of the fiche format and the reader index card system.

5. A similar explanation of the home viewers was given by demonstration only.

6. Students were told when and how they would receive their home viewers. Student responsibility for lost, stolen, or damaged equipment was established.

7. Students were told that the information obtained from them during the experimentation would not be used in their training evaluation.

8. After the orientation briefing, the students were given a few minutes to use the viewers in order to become more familiar with them.

Prior to the official starting time for Block II, students in the experimental classes received their home viewers. During the first experimental week, the rented truck was used to deliver the readers to students living both on-base and off. The distribution process took approximately 5 hours (12 students were involved). This unusually long delivery time was due, primarily, to several factors: first, four students lived off-base and this extended the delivery time substantially; in addition, the home viewers had not yet been unpacked and they required the same setup and check-out procedure as described for the classroom viewers. After the viewers were operative, students were given a brief description of their loading and operating characteristics.

After the first experimental class had completed its Block II examination, the home viewers were returned to the base and stored in the Requirements Unit. Students who lived off-base returned their readers to the Requirements Unit. The resident students went with the truck to retrieve their home viewers and received their receipt for them. This process took approximately 1.5 hours.

The home viewer delivery and pickup procedures were simplified and the time required to accomplish them was reduced for the next two experimental classes. The Requirements Unit assumed responsibility for storing the equipment when it was not in use and for its delivery and retrieval. Students who lived off-base were issued home viewers by the Requirements Unit and these men were responsible for setup and return at the end of the experimental period. Students living on-base received permission from their squadron commander to be in their rooms during a designated hour to receive their viewers and sign the hand receipt for them. Several squadron commanders requested that remedial slips which indicate the time and place of viewer delivery be

furnished to the members of their squadron. This procedure, coupled with the fact that the viewers were in operating condition, reduced delivery time to approximately 2.5 hours (including the time it took to load the readers on the delivery vehicle). Squadron and Department liaison times were estimated at 2 hours per xperimental week. Pickup, storage, and preparation of hand receipts represented approximately 4.5 hours. Readers were delivered during a designated hour on the first day of class and were picked up during the same time period exactly one week later. All students signed hand receipts for the equipment when they received it and got the receipts back when they turned in the readers.

Equipment Storage

The Requirements Unit stored both the classroom viewers and the home viewers, in their shipping boxes, while they were not in use. A disaster control storage room was used during the experimentation and, although it was sufficiently large to handle the 26 viewers involved in this effort, it did not appear large enough to handle the storage requirements if a large-scale conversion to microform were initiated. This room had the advantage of being located near the loading ramp and also close to the classroom itself. During the conduct of the experiment itself, the classroom viewers were taken to the classroom in the shipping boxes and the empty boxes returned to the storage area. Home viewers were delivered in their boxes and the students were responsible for storing the boxes in their residences for the week during which they kept the viewer. Students who lived on-base usually checked the boxes into a storage area in the residence hall. These students were required to keep their viewers in a wall locker when they were not being used.

Equipment Use

The microform viewers were used by the experimental students in a way which was consistent with the use of hardcopy in other classes. That is, the classroom viewers remained in use for the entire 6-hour lecture period each day, with the exception of break times. Home study time estimates by students ranged from 3.5 hours to 40 hours for the week of training and these estimates yield an average use of approximately 13 hours each for all experimental students. Equipment abuse in the classroom itself did not appear to be a problem since all in-class viewer use was monitored by the instructor. In this study, at least, equipment abuse outside the classroom was not a problem because student responsibility for lost, stolen, or damaged equipment was stressed in the orientation. Several students asked about the possibility of taking their viewers out of town or off-base for the weekend to study elsewhere. The instructors and supervisors decided that a man may take his reader with him since he was responsible for it and would have to pay for it if it were damaged or lost.

There was only one slight classroom interruption due to the presence of the viewing equipment; a reader lamp failed and was replaced immediately. In addition to these equipment considerations, none of the fiche or software support materials were lost or damaged during any of the three experimental periods.

It follows from the above discussion that maintenance requirements were minimal during the experimental pericd. For each of the experimental classes, the viewer cleanup and reassembly procedure described earlier in this section was followed prior to the first day of class. Since each classroom reader was used over 24 hours during the week's instruction, this cleanup was an important part of the preparation for the next class. Fingerprints, pencil marks, and smudges

appear on the screen itself, fingerprints, dust and dirt accumulate on the fiche carriage, and dust particles began to settle on the interior mirrors. Outside tampering with the equipment was minimized by covering the viewers at the end of the shift each day. The fiche themselves were replaced with new fiche prior to the start of each new Block II experimental class. The dust and dirt particles which accumulated on the fiche would have been very distracting when magnified 18 times. Attempts to clean the fiche usually result in scratches or other damage to the film surface. One problem area noted was with the diazo film dissemination copies used in this experiment; the negative-image fiche had a tendency to buckle slightly with extended use because the film held heat from the light source. This did not occur with the positive-image fiche.

Three additional viewers were available for use as replacements if any major maintenance or repair had become necessary during the experimental period. However, during the preparation and experimentation, only very minor repairs were required. In all, two classroom reader lamps and one home reader lamp were replaced. Two additional classroom reader bulbs began to discolor (turn brown on one side) after approximately 1.5 weeks of use. Since this discoloration affected the screen presentation, these bulbs were also replaced.

IV. INSTRUCTOR MICROFORM USE ANAL SIS

Three instructors were involved in the experimentation. As mentioned in Section II, each taught the Block II instructional sequence ("Basic Computer Operation") to a control class, which used the revised training manual in hardcopy form, and an experimental class, which used microform materials exclusively. Each instructor was given a thorough explanation of the operating characteristics of the viewing equipment and of the formatting technique applied in presenting the materials on microform but no attempt was made to influence the teaching technique employed in the classroom. The instructors were asked to use the technique which they felt was most appropriate in view of the equipment used. Each instructor followed a detailed Block II lesson plan which outlined the points for emphasis and the sequence in which they were to be taught. This outline corresponded very closely to the organization of the Block II training manual.

The Instructors were interviewed periodically and each experimental class was monitored daily to obtain information regarding the effect of the microform system on teaching technique and the role of the instructor and to document changes in procedure necessitated by its use. The monitoring activity showed that the general approach to teaching the course, independent of the medium of presentation, varied from instructor to instructor. For example, the amount of feedback or interchange which the instructor attempted to elicit from his students varied widely. One instructor was very good at drawing out student response. He encouraged questions from the class and handled them very well. He attempted to get each student to participate in class discussions by asking questions and had the students answer the review questions verbally in class. The second instructor was much less

concerned with feedback from his students. He did not solicit questions from the class as strongly as the first instructor had, although he handled them well when they were asked. He seldom asked questions of the class and the review problems were answered in written form and handed in rather than answered verbally in class. Compared with the previously mentioned instructor, his class placed more emphasis on lecture and less on discussion and student participation. The final instructor used the lecture method of presenting the material almost entirely and asked only those questions suggested in the training manual. Student participation and discussion was minimized in his class.

There was also considerable variation among instructors in the use of visual aids and the chalkboard to illustrate or emphasize certain points covered in the lecture. One instructor used illustrative slides sparingly and used the chalkboard only once during the entire week. Another instructor used slides to present pictures of equipment which had only been described in the manual and used the chalkboard to emphasize the main topic areas of his lecture, and the third instructor used both slides and the chalkboard to provide illustrations and examples throughout the week.

The three instructors also differed in the amount and type of material presented in lecture which digressed from the main points of the lesson plan.. This varied from a point by point sequential "rehash" of material in the training manual to a relating of the instructor's past experience in the field to illustrate what can happen in the actual machine room environment.

Finally, there was variation in the way the instructors moved about the room as they addressed the class. One instructor continually paced the front of the room as he talked, while another never left the

podium. The third fell between these two extremes, occasionally moving from place to place during the course of his lecture.

These variations in the general instructor approach to teaching the course were mentioned in this section to indicate that, although the lesson plans and objectives of the course are the same for all instructors, individual teachers may be differentially effected by the introduction of a new medium for presenting the instructional materials. These effects may be evidenced in the manner and degree to which new equipment is incorporated into existing teaching methods and by the changes its use necessitates in classroom technique.

The degree to which the microform equipment and materials were used as an instructional tool also varied from instructor to instructor. One instructor used the microform materials exclusively during the entire week he taught the course. That is, he did not even bring his notes or the hardcopy form of the training manual into the classroom but relied entirely upon the filmed materials for his orientation. His classroom viewer faced the front of the room so that the students could not see the presentation. He referred the students to the proper frame by using the coordinated index card located on each reader. This particular instructor continually referred to the supplementary material contained in ROWS B and D of the fiche. His use of the materials and equipment did not change noticably from the first day to the last.

The second instructor also attempted on the first day of class to use the microform materials exclusively. However, this proved very difficult for him due to the big difference between the reader presentation and his usual method of keeping his orientation within the text. He had previously highlighted his training manual with various colors in

order to quickly identify main ideas within the text. He had then directed students to that general area of the manual and began to lecture on the topic area identified. The microfiche presentation, of course, could not be highlighted and the points he wanted to emphasize were not easily identified. Therefore, after the first day, he began to use both his highlighted manual and the reader presentation. His technique was to identify what he wanted to emphasize using his revised manual, locate the corresponding material on the fiche, direct the students to the proper frame, and begin to lecture. His viewer again faced the front of the room and he directed the students using the reader index cards. This instructor only occasionally referred to the supplementary material in class, but advised his students to review ROWS B and D in their home study.

The third instructor involved in the experimentation also had initial adjustment problems as he attempted to use the fiche. However, this instructor decided to discontinue the use of the microform presentation and to rely on his revised training manual in the more familiar hardcopy form. His students, of course, continued to use the microform materials. For referral purposes, he labeled each page in his training manual with the fiche number, row, and frame number of its corresponding location on the fiche. For example, a page labeled 4-C-3 would contain material located on fiche number 4, row C, column 3, and using this system, the instructor could direct the students to the material to which he was referring.

This description of how the microform system was used by the participating instructors as an instructional tool illustrates that there are a variety of ways that the microform viewer could be incorporated into the teaching method. However, the particular microform viewer used in the experimentation did have several disadvantages which

required some adjustment on the part of the instructors. For one thing, the size and bulk of the reader made it difficult for the instructor to maintain visual contact with all of his students as he lectured. Eye-contact and facial expressions are normally important types of feedback which the instructor uses to determine whether his students are understanding particular topic areas. Obviously, this loss of visual contact differentially effected the instructors depending upon how much importance they normally place on feedback from their students, but each of the instructors mentioned this as a problem. One of the instructors partially alleviated this problem by pacing the front of the room as he lectured enabling him to see different students as his angle of vision changed. In this regard, the size of his viewer presentation allowed him to maintain his orientation to the text from various parts of the front of the room. Again, individual instructors have preferred lecture styles which include moving about the room for some and remaining stationary for others and it is difficult to adapt established lecture habits to fit changing situations.

The use of visual aids and the chalkboard was also affected by the microform system used in the classroom. Students in the back of the room were required to stand in order to view the lower portion of the projection screen due to the interference of the reader. This position made it very difficult for them to take notes on the slide materials presented. This same difficulty also occurred with the use of the chalkboard. In this case, the adjustment was made by the instructors who attempted to write on only the upper portions of the board. To accomplish this, the shorter instructors elevated themselves by standing on a short bench located in the front of the room. With the exception of the interference due to its size, however, the microform equipment

worked very well with the dim lighting conditions inherent in the use of the slide projector. In fact, one instructor often left the slide projector on and the lights off even when there was no image presented on the projector screen.

Another disadvantage of the microform system used in the classroom was the volume of the fan noise when all the viewers were in use at the same time. It was difficult for the instructors to speak at a level which could be heard above the fan noise for the entire six-hour lecture period each day. The students also had problems hearing the comments of other students who were facing the front of the room. Difficulty in hearing was compounded by the lack of eye contact.

There were three additional disadvantages in the classroom which were based more on the microform concept itself than on the particular viewers used in the study. First, the printing on several diagrams and flow charts was too small to be read on the viewer when these charts were reproduced to be presented on a single "frame" of the fiche. This was especially problematical to the instructor who did not have a hardcopy version of the training manual in the classroom for reference. It was suggested that xerox copies of these diagrams and charts be distributed to the students as supplementary hardcopy materials but this was not done. Of course, future applications of the microform technology for presenting instructional materials could overcome this problem through improved planning in the original filming procedure.

Secondly, the pages as reproduced on the fiche were not numbered, due to the particular format employed in the study. This caused some minor orientation problems because of the double frame presentation capabilities of the classroom viewer and the fact that the fiche-insertion procedure had not been stressed as a potential source

of difficulty. In general, however, the reader index card was used very effectively by the instructors to direct their students to particular desired frames.

Finally, the instructors' review of the workbook problems contained in ROW A of the fiche was quite awkward because the specified reduction-ratio employed in the study required the use of 13 different fiche That is, an overall review of the training manual (accomplished by scanning ROW A of the fiche) required frequent removal of one fiche and insertion of another. The production of an additional fiche which presented all workbook and review problems in one place would resolve this difficulty.

The above disadvantages of the microform system for instructor use in the classroom should not be considered sufficient to legislate against the use of this medium of presentation in future technical training programs. All can be adequately resolved through equipment improvements and proper instructor indoctrination. The wide variety of teaching approaches and techniques evidenced in this study further emphasizes the need for a thorough group indoctrination of all primary and alternate instructors concerning the use of microform in the classroom. This would allow them to share their ideas of methodology and to learn the advantages and possibilities of microform beyond their use as a book substitute. The indoctrination could, for example, emphasize the flexibility of microform as a teaching tool and consider ways to better employ the unique formatting or organizational capabilities of the fiche in the classroom. In addition, it could alert the instructors to the various disadvantages inherent in the use of the particular system employed and allow them to develop strategies to counteract these disadvantages. For example, in the present study, fan noise and loss of eye-contact were problems which could have been at least partially

counteracted by having the instructors walk among the students as they lectured. They could have used the students' viewers to maintain their orientation and check student progress and this technique possibly would have resulted in more student questions and increased student participation in the class. In other words, the indoctrination session would better prepare the instructors for the situation they will encounter in the classroom.

V. EXPERIMENTAL RESULTS

Student Use of Materials

Before the effects of introducing the reader-fiche system to the experimental group can be properly assessed, it must first be established that student use of the instructional materials was comparable for the experimental and control groups. Classroom observation indicated that the viewing equipment was in use during the entire 6-hour lecture period each day. Its use as an orienting method for following the instructors' lecture is comparable to the use of the training manual in hardcopy form by the control classes with one exception. Students in the control group made occasional marginal notations, highlights and corrections in the training manuals whereas the use of microform materials by the experimental group necessitated taking notes on a separate pad and relating them to the presentation. Overall classroom exposure to the instructional material, however, was identical for the two groups.

Information regarding use of the instructional material outside the classroom was obtained from the student-use check lists filled out by each participating student. It revealed that students in the control group spent an average of approximately 15 hours reading the training manual outside the classroom during the one-week period examined, compared with 13-3/4 hours per student for the experimental group. The fact that the control students averaged 75 minutes more of outside study possibly reflects the fact that this group contained a lower percentage of airmen whose study time is limited by squadron duty and lights-out conditions in the residence halls. This interpretation is substantiated by considering the range of outside reading behavior. For the control group, the overall range was from 2 hours, 20 minutes

to 49 hours of outside reading compared with from 3 hours to 44 hours for the experimental group. Separating this data by rank, however produced the following results:

Control Group -- Airmen, 2-3/4 hours to 26 hours: NCO's, 2 hours, 20 minutes to 49 hours.

Experimental Group -- Airmen, 5-1/2 hours to 13 hours: NCO's, 3 hours to 44 hours.

These data quite probably approach the upper limits of time available for outside study to students in the categories considered, especially since additional time was spent on workbook and review problems. It was estimated that if airmen utilized all available time, including week-ends, their outside study could not exceed 30 hours. When the NCO's from both groups who studied over 30 hours outside the classroom were ignored in the calculations, the difference between the two groups in average study time per student was reduced to just 20 minutes over the one-week period (N = 34 for the control group and 32 for the experimental group). Since these data were based entirely on subjective estimates by the students, more rigorous comparative statistical procedures were not applied. The original 75 minute discrepancy represents only an eight percent difference in outside study time between the two groups and supports the conclusion that exposure to the instructional material outside the classroom was comparable for the two groups.

Students in the experimental group spent an average of approximately one-hour of their study time reading the additional information presented in ROW B of their fiche and an average of approximately 30 minutes reading the complementary material contained in ROW D for a combined total of 1-1/2 hours per student reading the supplementary materials. This compares to an average of approximately one-hour

per control student reading the additional and complementary materials combined on the back pages of the hardcopy training manual. The 30 minute difference between the two groups in the use of supplementary materials possibly reflects the value of the formatting technique employed in presenting the material to the experimental classes. It is also possible, however, that this difference reflects the manner in which the data were obtained from the two groups. That is, questions regarding the use of additional and complementary materials were combined by necessity for the control group while separate estimates were obtained from the students in the experimental group.

Additional time spent working the workbook and review problems was very comparable for the two groups. The control group reported to have averaged 3-3/4 hours on the review problems compared with 4 hours for the experimental group.

Formal Examination Results

Three sets of examination scores were recorded for use in the analysis of the effects of the fiche medium on achievement. Scores from Block I, Block II, and Block III were tabulated for this purpose, although the experimental conditions were confined to Block II. Material in the two-week Block I sequence includes basic information on Air Force Policies and Procedures, including training orientation and explanation of the operation of peripheral computer equipment. Test scores for Block I reflect written and performance evaluations. Because there was so little basis for statistical comparison of the experimental and control groups (some aptitude scores were available but the data were not complete), Block I scores for each of the samples were used as a basis for determining if the groups identified in Section II were drawn from the same population. The conditions under

which all three groups (control, revised, and experimental) were treated in Block I and in Block III were not designed to vary in any systematic way. Block II, the experimental week, provides instruction in computer components, computer functions, and computer languages and is basically an introduction to the machine and to the procedures for computer operation. Block III is a machine room application of Block II material, and as such the analysis of Block III evaluations is considered pertinent to the measurement of performance in Block II.

In this discussion the following terminology is used to identify each of the three groups of examination scores. The first group of scores represents the only four classes of trainees that completed Block II using the hardcopy form of the unrevised training manual, and completed Block III under the new performance evaluation procedure that was instituted under a concurrent service test. This group is designated in this discussion as Control Group C. The second group consists of the three classes which used the revised hardcopy edition of the training manual. This group is identified as Control Group R. The Experimental Group E consists of the three classes that used the microform materials. All three groups used the same Block I and Block III material and were evaluated with the same instruments for Blocks I, II and III. Only data from those trainees who successfully completed all three blocks of instruction are included in this analysis. Table II compares the pass/fail ratio of the three groups. Failure is

Table II. Numbers of Students Who Passed or Failed Each Block

Group	Block I		Block II		Block III	
	Pass	Fail	Pass	Fail	Pass	Fail
C	41	1	40	0	40	0
R	34	4	36	2	35	3
E	33	1	34	0	32	2

interpreted here to include scores of less than 60 on an initial examination attempt. In each case, after successfully repeating the section previously failed, the trainee eventually continued into the next block of instruction. Two of the R group failures and one of the E group failures in Block III were finally washed out. With zero failures for Control Group C, it is difficult to use C as a basis for comparison. (The Control Group R had 2 failures in Block II, and 3 failures in Block III, however, there was a nigher rate of failure in Block I for Group R.) Since no statistical inferences should be drawn from this limited data, note only that the experimental Group E did not experience any failures during Block II, and only two failures during Block III, one of whom scored below 60 on his first attempt through Block I also.

A frequency distribution of grades for Blocks I, II and III is shown in Table III. Table IV presents the arithmetic mean and standard deviation for each block of scores for each of the three groups.

Table V presents the results of an analysis of variance for Block I scores which was computed to determine if the differences in the variances were attributable to sampling errors. The Table of F values indicates that it is appropriate to use tests for significance of means requiring equal variances in the populations. F with 39, 30 degrees of freedom at the .05 level must be equal to or greater than 1.79 for significance.

The unmodified t-tests for significance of means for each of the three groups are shown in Table VI. The only significance encountered was in Block 1 in which the revised hardcopy Control Group R performed significantly better at the .01 level than the Experimental Group E. Since no treatment was involved in Block I, a simple t-test of the two independent groups (R with E) was sufficient to establish significance.

Table III. Frequency Distribution of Raw Scores With a Class Interval Five

Score Interval	Control Group C Unrevised Hardcopy (N = 40)	Control Group R Revised Hardcopy (N = 31)	Experimental Group E Microfiche (N = 32)
	Block I		
96 - 100	0	1	0
91 - 95	5	5	0
86 - 90	9	7	5
81 - 85	7	6	6
76 - 80	11	8	11
71 - 75	5	1	6
66 - 70	2	1	3
60 - 65	1	2	1
	Block II		
96 - 100	0	0	0
91 - 95	2	1	1
86 - 90	4	3	1
81 - 85	7	4	4
76 - 80	8	6	8
71 - 75	8	6	7
66 - 70	8	8	5
60 - 65	3	3	6
	Block III		
96 - 100	2	1	4
91 - 95	7	3	5
86 - 90	6	5	5
81 - 85	4	6	4
76 - 80	5	6	6
71 - 75	5	2	3
66 - 70	8	5	3
60 - 65	3	3	2

It was on the basis of this test that it was decided to use an analysis of covariance for groups R and E to determine if there was any significant difference in performance in Blocks II and III, adjusting for or co-variating the differences in Block I. The results of that test are shown in Table IX. Since the t-test of Blocks II and III for the C and R groups and the C and E groups did not show significance, it was not necessary to proceed with any more rigorous tests, and it can be assumed that any differences in scores between the Control and the two other groups can be attributed to chance alone.

Table IV. Raw Score Means and Standard Deviations

	C N = 40		R N = 33		E N = 32	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Block I	81.7	7.1	84.1	6.3	78.1	6.5
Block II	76.2	7.6	75.9	7.7	73.9	7.6
Block III	79.6	10.8	80.1	10.1	82.9	10.7

Table V. Table of Variances, Block I

	C-R	C-E	R-E
Variance S^2	1.275	1.19	1.07

Table VI. Table of t Values for Significance of Means

	Block I		Block II		Block III	
	R	E	R	E	R	E
C	1.476	2.206	0.203	1.271	0.218	1.300
R		3.698*		.989		1.049

* for 60 df t = 2.660 at .01 level of confidence

There was no control for the relative numbers of airmen and non-commissioned officers in the Control Group R and Experimental Group E. Data for each of these groups is therefore shown separately in Tables VII and VIII. Tables VIIa and VIIb present the raw score means and standard deviations for airmen and non-coms respectively and the results of the t-tests of significance for the two groups are given in Table VIII. The only significant difference in means of the two groups occurred in Block I scores for the airmen.

Table VII. Means and Standard Deviations

	VIIa. Non-Commissioned Officers				VIIb. Airmen			
	R N = 12		E N = 8		R N = 19		E N = 24	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Block I	81.7	6.5	78.9	6.2	85.7	5.7	77.4	6.7
Block II	74.4	5.4	73.0	6.8	76.8	8.8	74.7	8.1
Block III	84.5	8.9	85.7	8.6	77.4	9.8	80.6	11.8

Table VIII. T-Test Values

	VIIIa. Non-Commissioned Officers	VIIIb. Airmen
	R-E	R-E
	t values	t values
Block I	1.103	3.918
Block II	.564	.721
Block III	.351	.873

Table IX. Test of Significance of Influence of Block I Scores on Block II and III Scores

Source of Variation	df	Sum of Squares	Mean Squares
Total	61	7405.4	2160.04
Within	59	4667.4	791.04
Difference	2	2738.0	1369.00

$F_{2,59} = 1.73$. For significance at .05 level $F_{2,59} \geq 3.15$

There were no significant differences in performance in Blocks II and III for any of the three groups. Noting, however, that Group R performed significantly better than Group E in Block I where there was no difference in the treatment, it is appropriate to look at the analysis of covariance to determine whether there is significant difference in Blocks II and III, having removed the bias introduced by class differences as revealed in Block I scores.

Table IX indicates that when the criterion means of the two subgroups are adjusted for the group difference as reflected in Block I scores, the difference in achievement in Blocks II and III cannot be attributed to anything but sampling error. Therefore, the difference in means for Block I, although significantly higher for the control group, is not sufficient to indicate that the difference in Blocks II and III scores is an indication of superior achievement using microform materials. In terms of magnitude, the Block I mean for the control group was 6 points higher than the experimental group, for Block II it was only 2 points higher and in Block III, the experimental group scored an average of 1.8 points higher than the control. In terms of the research hypothesis, however, it must be stated that there was no significant difference in performance among the three groups using the standard, revised and fiche instructional materials in Block II, nor was there evidence of different performance for each of the three groups in Block III.

As a point of information, this analysis revealed a noticeable difference in class variance in Block III as compared with Blocks I and II (Table III). Another interesting statistic is revealed in Tables VII and VIII, where the non-commissioned officer data is separated from the airmen data. Airmen scored somewhat lower in Block III than non-commissioned officers and had a substantially higher

degree of variance in each case, as revealed in the standard deviations (no tests for significance were performed). In addition, the t-values for non-coms and airmen indicate that most of the difference in means between the R and E groups is found in the airmen category. The non-commissioned groups appear to be considerably more homogeneous in all these measures.

Student Subjective Evaluations

The students who participated in the classroom experimentation are unique in having experienced the sustained use of microform as the exclusive medium through which instructional materials were presented to meet defined course objectives. Their opinions concerning the questions surrounding the use of educational microforms were obtained through a questionnaire/interview technique and are summarized with regard to the following considerations.

1. Student attitudes
2. Effect of microform use on study habits
3. Fatigue characteristics
4. Polarity preferences
5. Fiche organization and format
6. Viewer preferences
7. Student criticism and recommendations

Student Attitudes. Response to a pre-class questionnaire indicates that only five of the 34 students in the experimental group had any experience with microforms prior to this class. Most of this experience represents reference work for research papers in high school or college. Only one of the students with previous microform experience expressed negative feelings toward its use.

Students were als asked in the pre-class questionnaire whether they thought the use of microform would help them or hinder them in

their Block II experience. Only four students thought it would hinder them, 20 (57%) thought it would help them, and the remaining 11 students had no opinion. The primary reason given by those who thought it would help them in Block II was that the novelty of the system would hold their interest longer and lead to improved study habits. Those who thought the system would hinder them cited lack of reader portability and the inability to underline or make marginal notations on the fiche as the primary influencing factors.

It can be concluded from these remarks that prior to their experience in Block II, student attitudes toward microforms were generally positive and that there was little prejudice or resistance to the use of this new medium of presentation.

In the post-class questionnaire, these same students were asked whether their attitude toward the microform system had changed with extended use. Nineteen students or 56% of the experimental group responded that their attitudes had changed. In 12 of these cases, student attitudes improved over time while for 7 students they worsened. Those with increasingly favorable attitudes commonly thought when the class started that the fiche would be more difficult to use than a book and would interfere with or complicate their study methods but found with actual use that the organization of the material and the additional information included on the fiche actually made study easier and more efficient.

Those with increasingly negative attitudes toward microforms commented that they became aware of more and more deficiencies in the system with extended use. For example, it became increasingly troublesome to remove the readers from the wall lockers and set them up for just a few minutes use; it became bothersome to have to exchange

fiche in order to review previously read material: and students began to lose interest in the system as notetaking became a chore and the inability to highlight became more noticeable.

These comments imply that while initial impressions are important in the introduction of new learning equipment, attitudes and opinions do change with extended use if students are not given an opportunity to discontinue using the system when first impressions are unfavorable. If there is a value added by the system (such as the separation of main text and supplementary materials in the format employed in this study), this value becomes recognized with continued use. If this added value is of no particular advantage to a given student, equipment deficiencies and inconveniences become more noticeable and his attitude becomes more negative.

Students were also asked whether they would prefer to continue using the microform viewers or return to using the training manuals in hardcopy form. In response to this question, 19 students (56%) stated that they would prefer to return to the use of the manual in hardcopy form. These students stated three major objections to the continued use of microforms:

1. The use of microforms limited study to the location of the readers, which was not always the best environment for study.

2. The inability to highlight or make marginal notations on the fiche as can be done in the manual necessitated more notetaking.

3. Review required that the fiche be changed in order to access previously read materials which is not true with the manuals.

The ten (29%) who would prefer to continue using the microform readers cited three main reasons:

1. The fiche presentation was better organized; essential materials were indicated so that supplementary material need not be read unless problems were encountered or time permitted.

2. Several students could read faster with less eye strain using the microform presentation. (This response and the one immediately preceding are quite probably interrelated.)

3. The reader presentation forced students to take notes and in that way learn the material better.

Five students also commented that they would like to use both the viewer and the training manual concurrently. These students indicated that they could work faster using the fiche and liked its organization but would also like to have a manual so that they could study where they wanted to.

Effects on Study Habits. A majority of the students (74%) indicated that the reader-fiche system altered their study methods in some way. Some of these changes were positive, some negative, and some were open to interpretation. On the positive side, several students felt that studying was less tiring using the viewer and that they could study for longer periods of time. Other positive comments were that students made it a point to study more due to the novelty of the system and that their hands were free to do other things while they studied. On the negative side, some students did not take advantage of short periods of study time since it was necessary to remove the reader from the wall locker and set it up prior to use. Others resented being restricted to the barracks rather than spending more time in other,

quieter locations. In addition, students were also restricted to their desk when they normally would have relaxed in bed or in a chair while they read.

Several students indicated that the reader presentation forced them to take more notes rather than highlight in the manuals. Some simply did more reading since they could not review only what had been highlighted. These last comments are subject to interpretation. While they might seem to the student to be disadvantages, they might actually help him better learn the material. Some of the highlighting requirements may actually have been accomplished for the student by separating the supplementary and complementary material from the main text.

Seven students or 21% of the experimental group felt that their home study needs were not met by the reader-fiche system used in the residence halls. These students felt that the system was inadequate for review because main points could not be highlighted for emphasis and the fiche had to be frequently changed in order to access material. In addition, having their study restricted to the barracks resulted in frequent interruptions by other trainees inquiring about the viewing equipment. The majority of the students (79%) however, indicated that they were able to adequately meet their home study needs using the microform system.

Since notetaking is an important aspect of almost any course-related learning experience, this particular study task was examined in some detail. The extent of notetaking activity, as determined from response to the post-class questionnaire, is presented in Table X.

Table X. Experimental Student Response to the Question, "Did You Take Notes on The Material"?

	In Class	At Home
None	1 (3%)	8 (24%)
A Few	15 (44%)	17 (50%)
Extensive	18 (53%)	9 (26%)

These responses indicate that a majority of the participating students took at least a few notes on the instructional materials. Less than one-third of the experimental group had difficulty taking notes while using the microform materials. These difficulties were based on four main problems.

1. It was reported that notetaking was more difficult and time consuming than underlining or making marginal notations so that it was impossible for some students to complete their assignments in the limited time available to them.

2. It was necessary to take more extensive, thorough and precise notes to be able to relate them to the discussion or to the text for review at a later time.

3. When sentences were interrupted at the end of a fiche, it was difficult to concentrate while making the transition to the next fiche.

4. Fan noise in the classroom coupled with the rapid teaching pace made it difficult to hear and take notes on all that was said in the lecture.

The student responses to the questionnaire give no indication that the physical characteristics of the viewers in conjunction with limited work space caused difficulties in the actual physical act of taking notes.

Fatigue Characteristics. Response to the post-class questionnaire indicates that fatigue resulting from microform use was not a pervasive problem in this experiment. The majority of the students (74%) felt that it was not necessary to take more study breaks using microforms than it would have been had hardcopy materials been used. Several students did, however, indicate that using the viewer-fiche system resulted in physical and/or eye fatigue over and above that resulting from hardcopy use; nine indicated eye fatigue and four indicated both physical and eye fatigue. Student comments indicate that the primary cause of eye fatigue was the nonuniform distribution of light which resulted in a bright spot on the screen. In this regard, slightly more of the students experienced eye fatigue using the home viewer than using the classroom viewer (11 students compared to 9). Student responses to other questions indicate that the center screen brightness was more noticeable on the home viewer.

Physical fatigue was associated with restrictions imposed by the reader-fiche system itself. Limited work space and the size of the reader made it difficult to alter the physical position of the reader so that students were forced to maintain a rather consistent posture to use the system.

The percentages enumerated above are based on students' subjective feelings of fatigue since measures of objective fatigue manifest in performance decrement were not available. Although fatigue was present using the viewer-fiche presentation (as in any extended reading task), the students were sufficiently motivated to complete the necessary readings and meet course requirements.

Polarity Preference. The participating students expressed a very definite preference for the negative-image fiche for both classroom and home study uses. Almost 75% of the experimental group

preferred the negative-image while only 15% preferred the positive-image fiche. The remainder of the class stated no preference or indicated that their preferences were dependent upon the situation. The primary factor which influenced student preferences was eye-strain. The negative-image fiche reduced eye-strain by minimizing the glare or "hot spot" caused by nonuniform illumination and by reducing the distraction caused by dirt and dust on the film chip or on the fiche carriage glass plate.

Reduced eye strain was also the prime influencing factor for the five students who preferred the positive-image fiche. These students felt that they could read longer using the positive polarity because the image was much clearer and crisper.

These student comments were substantiated by the classroom observation. In each of the experimental classes, there was an initial exploratory period during which no polarity preferences were evidenced. As time passed, however, more and more students switched to the negative-image fiche so that the preference for this polarity was clearly established by the third or fourth hour of use. However, the student polarity preferences evidenced in this study should not be considered a recommendation to produce only negative-image fiche for future instructional applications. There were a few students who used only the positive-image fiche and with certain types of material (small diagrams, for example) and for particular applications the positive-image fiche was used by the majority of the students.

Fiche Organization and Format. Microforms designed for use in direct support of a particular course must meet specific, structured information needs as defined by the instructor or by the course objectives. In Air Force technical training programs, course objectives are

very rigorously defined. Therefore, the specific order of reading imposed by these objectives was followed precisely on the fiche. However, it is important that the film presentation be formatted and indexed in a way which adequately and conveniently meets the defined information needs.

Each of the thirteen fiche used in the course contained an eye-legible heading which included the number of the fiche, the number of the study guide to which it referred, and a brief description of its content. The fiche were also arranged numerically in the fiche container so that the user had easy access to specific fiche by number, by study guide, or by content. Almost 90% of the experimental group (30 of 34 students) felt that the indexing system adequately fulfilled their needs.

Another important consideration is the format or style of presenting materials. The innovative format used in this study (described in Section II) was responded to favorably by the experimental students. Seventy-one percent of those responding said they never became "lost" within the material and 77% had no difficulty locating specific required images. The reader index card used in conjunction with the format provided the instructor with a convenient means of orienting the students in the classroom. For those who did have difficulty, the problems arose mostly when changing from one fiche to another.

The majority of the students (85% or 29 of 34) were satisfied with the organization of the materials on the fiche. Those who were not, cited two important considerations. Occasionally, paragraphs or sentences were interrupted at the end of a fiche and it was difficult to hold a thought while making the transition to a new fiche. In addition, the two readers used by the students did not have identical x-y

coordinating systems or identical fiche loading characteristics and this caused some minor adjustment problems.

Seventy-five percent of the group preferred the organization of the fiche to that of a conventional book (17% preferred the book and 9% did not answer). They especially appreciated having the main text separated from the additional material which could be used if problems of understanding arose or if time permitted. They also liked having the review questions located directly above the materials relevant to them. It was much easier to check responses or find answers than having to page through a book.

Students who preferred the conventional book style cited not being able to underline or make marginal notations on the fiche. However, these responses are more relevant to the microform concept itself than to the particular organization of materials utilized in this study.

Students were asked to indicate how often they used ROWS B, D, and E of the formatted material.

Table XI. Student Estimates of Their Use of Supplementary Materials

	ROW B (additional explanation)	ROW D (complementary material)	ROW E (outline)
Always	7 (21%)	5 (15%)	0
Often	9 (26%)	8 (23%)	2 (6%)
Once in a While	16 (47%)	18 (53%)	6 (17%)
Seldom	2 (6%)	3 (9%)	3 (9%)
Never	0	0	23 (68%)

These responses are consistent with results from the student-use check list which indicates that students averaged one hour and 2 minutes of study time in ROW B and only 32 minutes in ROW D. They are also consistent with classroom observations which indicated that students were almost entirely dependent upon the reader index card for search and orientation and seldom, if ever, used the outline in class.

Thirty-two of the 34 students said that the additional explanatory material in ROW B helped them in their study, mainly by providing definitions of terms and illustrative diagrams which helped them understand the main text. Similarly, 76% felt that ROW D was helpful to them; the material presented there also helped them understand the main text but also provided material which was interesting to them and increased their awareness of the field in general. ROW E (outline) which was seldom used by the students, was found to be helpful to only seven students (21%). Those who responded negatively simply did not find it necessary to use the outline.

The location of the workbook and review problems directly above the relevant textual material proved very helpful to all but one student. It was much less time consuming to do the problems and check responses using this format.

In general, then, the formatting and indexing techniques employed in this study were responded to favorably by the students and used effectively by them in the course of their study.

Nineteen students or 56% of the experimental group felt that the notebooks helped them in their home study. Many of these students stressed the fact that the organization of the notebook allowed them to index material for easy reference later. Others said simply that they appreciated having the paper for notes and working problems. Other favorable comments were that the notebooks allowed them to study their

classroom notes at home and that once their home notes were complete, they were no longer restricted to the viewer and could study outside the barracks.

People who did not feel that the notebook helped them with their study commented that the spiral notebooks which were issued separately gave them a more permanent, better organized set of notes after the class was completed, whereas all the notebook was good for was holding the fiche.

There is an indication from these comments that the notebook-fiche holders would have been more valuable had the students been able to keep them after the class was completed. Knowing that they would only be able to keep their notes, they preferred to use the spiral notebooks in conjunction with their experimental materials rather than the loose-leaf note paper provided. Classroom observations indicate that in general, only nine or ten students used the notebooks provided for taking notes.

However, students felt that the fiche-container itself was a valuable aid. Thirty of the 34 students in the experimental group had no difficulty locating specific fiche since they were well indexed and labeled (each fiche contained an eye-legible heading which included a brief description of its content), and were arranged numerically. Student comments regarding the value of operating instructions and the format description were not available.

Viewer Preferences. The students were asked to state which of the two viewers (home or classroom) they preferred to use in accomplishing the two basic types of study tasks: reading and notetaking. Responses to these questions were not analyzed to make evaluative or comparative judgements of the particular readers used in this study but

rather to identify the machine characteristics which positively or negatively effect student attitudes toward and use of microforms.

For reading purposes, 25 of the 34 students (74%) preferred to use the home viewer. Eighteen of these 25 students cited a more uniform, constant focus which required fewer adjustments as the basis for their choice. Three students said that the single image was less confusing or distracting than the double image used in the classroom and the remaining students cited small size and ease of handling. Seven of the 9 students who preferred the classroom reader said that being able to view two images at the same time was the main factor influencing their choice. The other two students liked the more uniform distribution of illumination.

Similar reader preferences were stated for notetaking purposes: 23 students (68%) preferred the home viewer, 10 (29%) preferred the classroom viewer and one student had no preference. Again, the primary influencing factor was the better focus maintenance of the home viewer. Several students also cited the smaller size of the viewer which left more room for notetaking, the smoother operating fiche carriage mechanism, and the fact that the home viewer was closer to eye-level and allowed the students to get closer to the screen. One-hundred percent of those who preferred the classroom viewer cited its dual frame presentation capability.

Student Criticisms and Recommendations. Students were asked in the post-class questionnaire to identify possible deficiencies in the reader-fiche systems used in this study and to make recommendations for their improvement. Students identified four main problem areas regarding the viewers used in the classroom.

1. The most common complaint was the difficulty in maintaining hard focus on the viewer screen without constant adjustment, this

being especially true while scanning but also occurring in normal frame-to-frame operation. It is essential that hard, uniform focus be maintained in the operation of the viewer.

2. The size and bulk of the classroom viewer caused problems for several students. The reader left too little of the work surface for notetaking and tended to block the students' view of the instructor. Students recommended a smaller, more portable reader and/or a coordinated viewer-desk configuration with the viewer recessed to a more horizontal position.

3. Students complained of not being able to hear all that was said due to the fan noise when all readers in the room were on. It was especially difficult to hear the comments of other students who were facing the front of the room. Difficulty hearing the instructor was compounded by not being able to see his lips move due to the problem mentioned in number 2 above.

4. Another, although less serious problem with the classroom viewers was the uneven distribution of illumination. There was a tendency for the corners to be slightly dimmer than the rest of the screen presentation.

Students were less critical of the physical characteristics of the viewer used in their residences. Their responses are summarized in the following descriptions.

1. A common complaint with the home viewer stems from an Air Force regulation which states that all valuable objects in barracks must be stored in the lockers when not in use. The students found it bothersome to remove the reader from the locker, set it up, plug it in, insert the fiche, etc., each time they went to study. This resulted in a reluctance to use the viewer unless large segments of time were

available, whereas, the training manual in hardcopy form could be picked up and used conveniently whenever the student had a few minutes of free time.

2. Use of the home viewer restricted extended study to the location of the viewer. Students recommended a smaller, more portable viewer, perhaps battery operated, which could be easily carried by the students to wherever they wished to study.

3. Students recommended that the "bright spot" and the fan noise with the home viewer be reduced to minimize fatigue with extended study.

Two additional considerations which apply to the fiche concept itself rather than to the equipment used, should also be mentioned. As mentioned earlier, the use of the COSATI standard reduction ratio necessitated using 13 fiche to present the entire 185 page training manual. This made it difficult for students (both in class and during home study) to quickly and conveniently refer to material located on another fiche. When students wanted to refer to material covered earlier, they were required to remove one fiche and insert another, especially during review when this was done several times.

Students also recommended that paragraphs and/or sentences not be interrupted at the end of a fiche. Even though this occurred on only two fiche it was sufficiently irritating to be mentioned by several students. This type of interruption makes it extremely difficult to maintain a thought while making the transition to the next fiche.

VI. CONCLUSIONS AND RECOMMENDATIONS

The research project described in this report was executed in a manner consistent with achieving the primary objective of the larger research program of which it is one part: The identification of some of the innovative capabilities of microforms for presenting instructional materials and the development and evaluation of microforms for use as primary source materials in Air Force technical training programs. It was an exploratory study conducted to identify the advantages and disadvantages of microforms used to present instructional materials in the classroom. The introduction of the microform system into the training environment was examined as it affected the instructor, th student, and the supervisory personnel. Various difficulties or disadvantages of the particular microform systems used in the study were encountered in each of these three areas, as might be anticipated because of the unique nature of the experiment. The crucial point is, however, that the feasibility of classroom instruction through the microform medium has been clearly demonstrated and the concept of utilizing the unique characteristics of the microform to facilitate instructional communication has been operationalized.

The participating instructors agreed that there were two important disadvantages to the use of microforms in the classroom. Both were related to the physical characteristics of the viewer selected for classroom use. First, the size and bulk of the viewer made it difficult for the instructor to maintain visual contact with students as a method of obtaining feedback from them, and the viewer geometry interfered with the effective use of visual aids. Second, the combined fan noise, when all readers were in use, made it difficult to hear all that was said in the classroom.

These two disadvantages also effected the students in the classroom, of course. In addition, students had difficulty maintaining a hard, uniform focus on the viewer screen without frequent adjustment. Students also complained about the "hot spot" which resulted from the uneven distribution of screen illumination peculiar to presently available film viewers, but the primary disadvantage of microform use to the student was the inconvenience involved in using the home viewing system. Students were required to store the viewer when it was not in use and found it bothersome to remove the viewer from the wall locker, set it up, plug it in, and insert the fiche, each time they wished to study. Use of the home viewer also restricted extended study to the barracks. In spite of these disadvantages, however, the students were sufficiently motivated to complete the required readings and meet course requirements.

Administrative problems which required resolution prior to the introduction of additional equipment into the training environment included the provision and scheduling of facilities to be used in conjunction with the equipment, and the delivery, retrieval and storage of the equipment itself.

The problems and disadvantages of microform use encountered in this study indicate a need for the development of microform reading equipment designed specifically for instructional applications. All of the problems described above could be resolved or minimized through equipment improvement. A personal reader which combines portability with sturdy construction, adequate focus maintenance and uniform illumination characteristics is recommended for training applications. This "personal" viewer would have several advantages in addition to eliminating the size and fan noise problems encountered in the classroom

itself. First, its portability would free the students from being restricted to the location of the viewers. Second, it would simplify room provision and scheduling since the equipment would not remain in the room when not in use. Finally, it would reduce storage requirements and simplify the reader delivery and retrieval procedure. In other words, a personal viewer has advantages for the instructor, the student-user, and the administrator.

Actually, there are two options here: a viewer for home use and a viewer for classroom use. If instructional microform use should become pervasive in training, each trainee would be issued a reader at the beginning of his resident training. This reader would become part of his equipment compliment just as he has a desk, lamp, and locker. The classroom would be outfitted with permanent reader-work stations. In this manner, the system achieves the necessary flexibility and obviates transport and setup difficulties. While this equipment is not commercially available at this time, it is a function of studies like the one reported here to specify new requirements in order to advance the state-of-the-art.

Improvements in the viewing equipment itself would allow educational and training institutions to take better advantage of the unique flexibilities and capabilities of the microform technology for presenting instructional materials. This study emphasized the flexibility of microforms in the classroom by demonstrating that they could be used effectively by instructors who varied widely in teaching approach and technique. It also demonstrated that the serial presentation found in hardcopy materials could be improved upon using microforms.

While only one fiche format was utilized in this experiment it is clear that important simplification in the film presentation could be

achieved by using a higher reduction ratio in preparing the film material. If, for instance, a 42X reduction ratio were employed (instead of 20X), computer generated text becomes practical, fewer fiche would be required, and more flexibility in format is promised. That the innovative format employed in this study was accepted and used effectively by the students and instructors is an indication that microforms have an, as yet, unexploited value in addition to their use as a hardcopy substitute. It is this potential for adding value to instructional materials which makes microform an important educational technology of the future.

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13. ABSTRACT

This phase of the research in technical training microform applications explores the comparative advantages and disadvantages of microform in classroom training applications. A 30-hour instructional sequence entitled, "Basic Computer Operation" was selected from an on-going course at the 3750th Technical Training School, Sheppard Air Force Base, Wichita Falls, Texas. A two-stage filming procedure was used to convert the training manual used in the instructional sequence to an innovative microform format in both positive and negative film polarities. The major result of this comparative analysis is that Air Force trainees can and did use the microform systems effectively and intensively over a one-week period. No significant performance decrements were encountered in the experimental classes. This study also examines a number of important considerations involved in utilizing microforms for training purposes, including the impact of microform use on instructional routine, administrative-logistics considerations, and student study habits. A personal reader is recommended for its positive values in classroom use, student residence use, and logistics. The significant accomplishments of this study were the demonstration of the feasibility of the microform medium for classroom instruction and the development of an effective, innovative format which utilizes the unique presentation characteristics of microform to facilitate instructional communication.

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